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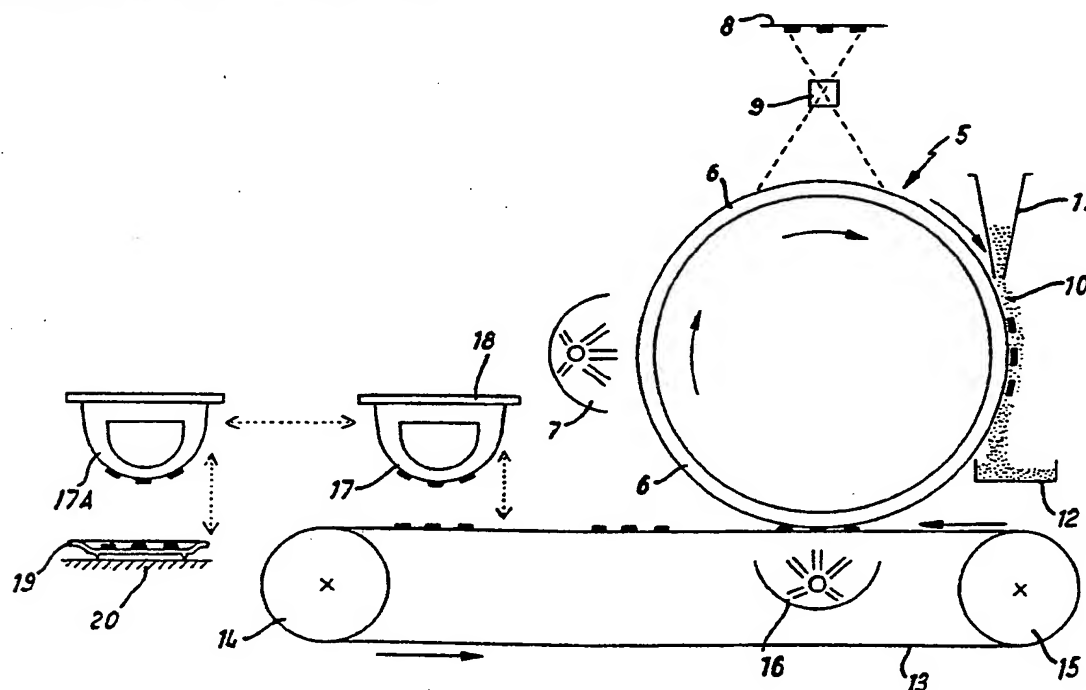
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(58) Field of search

UK CL (Edition K) B6C CGBB CGD CSSM

## (54) Transfer of electrostatically formed images

(57) An image transfer method comprises producing an image of an original pattern or decoration 8 by electrostatic means on the surface of an intermediate carrier member 13 and transferring the electrostatically produced image from the carrier member to a support surface by direct contact. The method may be used to produced lithographs or transfers in which case the support surface comprises a transfer substrate. Alternatively the method may be used for the direct decoration of articles 19 in which case the image is transferred from the carrier member to the surface to be decorated by one or more transfer stages involving direct surface contact.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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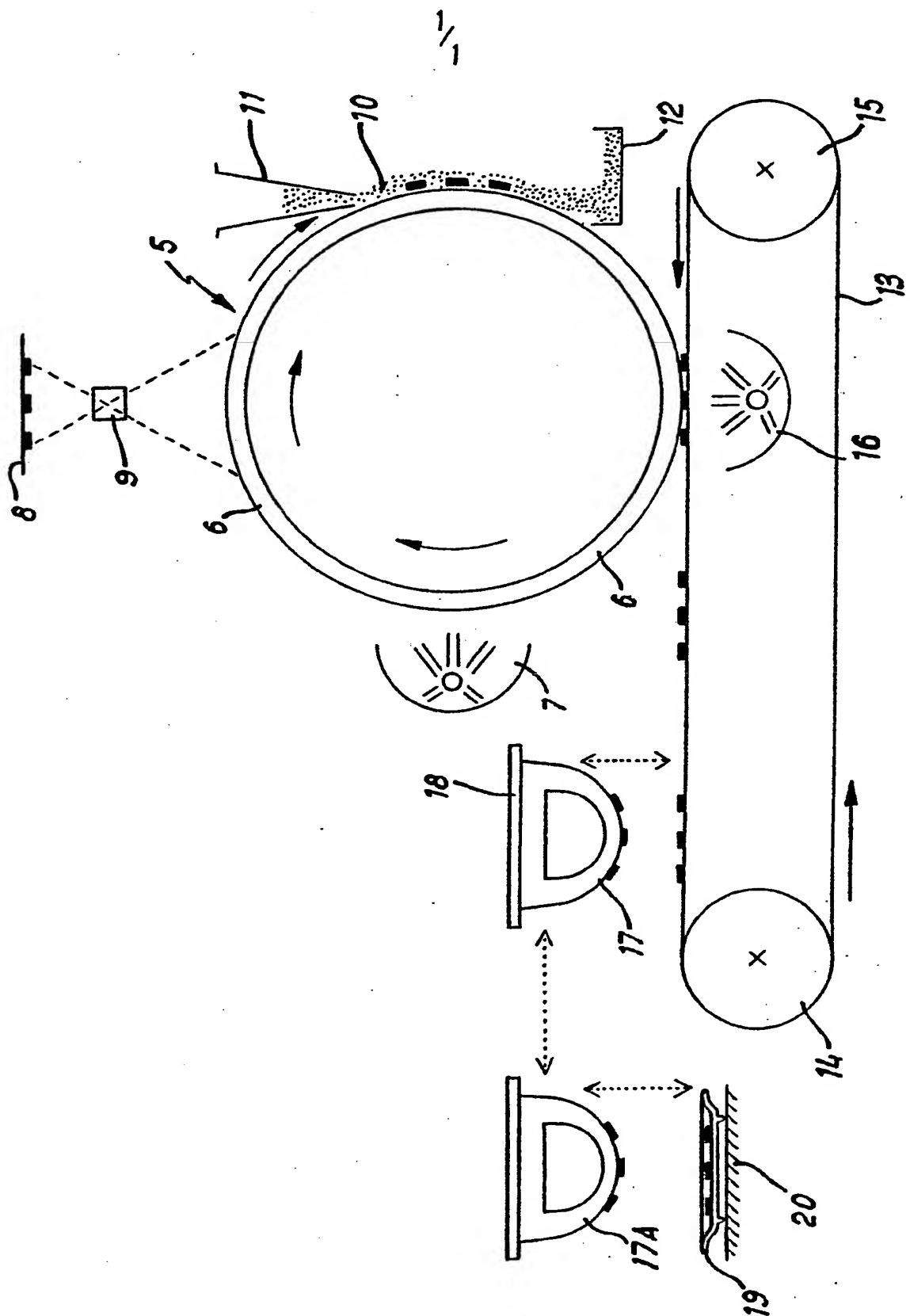


Image Transfer Systems

This invention relates to image transfer systems especially, but not exclusively, for use in applying patterns or decoration to the surfaces of articles such as ceramic tableware.

One conventional method of applying patterns to the surfaces of ceramic articles utilizes an intaglio plate into the surface of which the pattern to be transferred is etched or engraved. A decorating medium or ink is applied over the surface of the plate and doctored to remove excess, the ink remaining in the engraved areas then being picked up by a flexible transfer member and transferred to the surface of the article to be decorated. This technique suffers from the disadvantage that the preparation of etched plates of this kind is expensive and they are subject to wear, causing a reduction in quality of the image applied to the article.

A further conventional technique for use in decorating articles of ceramic ware involves the use of lithographs or transfers. According to this technique an image of the pattern or decoration to be applied to the article is printed by silk screen or other printing technique on to a transfer paper and is thereafter separated from the paper, applied to the article and

fired to fuse the pattern or decoration to the surface of the article. It has been proposed to modify this technique by applying the pattern or decoration to the transfer paper by reprographic means. This simplifies the technique and reduces costs but reprographic processes suffer from the disadvantage that transfer of the image from a carrier within the reprographic equipment to the transfer paper is effected electrostatically using corona discharge to cause the image to "jump" across a gap from one to the other. This results in a loss of definition of the transferred image, making such techniques less suitable for high quality image reproduction than screen printing or similar techniques.

It is an object of the present invention to provide an image transfer method and apparatus suitable for use in the decoration of articles of ceramic ware in which the disadvantages of previously proposed techniques are obviated or mitigated and finer resolution images obtainable.

According to one aspect of the invention there is provided an image transfer method comprising producing an image of an original pattern or decoration by electrostatic means on the surface of an intermediate carrier member and transferring the electrostatically

produced image from said carrier member to a support surface using a direct contact transfer technique.

Preferably transfer is assisted in the course of said direct contact transfer technique by application of heat and pressure. Transfer may also be assisted by corona discharge.

The method may be used in the production of lithographs or transfers for use in the decoration of ceramic articles, in which case said support surface comprises a coated paper or other substrate forming the base of the lithograph. Thus the invention also provides a method of producing lithographs or transfers comprising producing an image of a pattern or decoration by electrostatic means and transferring said image to the surface of a transfer substrate by direct contact therewith.

Lithographs or transfers are produced from the image-bearing substrate by application of a suitable cover coat or coats enabling subsequent release of the cover coat and image from the substrate and application thereof to the surface of an article to be decorated.

The method may also be employed for the direct decoration of articles, in which case said image is

transferred from said carrier member to the surface to be decorated by one or more transfer stages involving direct surface contact. In such cases said support may comprise the surface to be decorated but advantageously comprises an intermediate support member from which the image is transferred to an article of ware to be decorated by a flexible transfer member operative to pick-up the image and apply it to the surface to be decorated by contact therewith. The flexible transfer member advantageously comprises a deformable pad of silicone rubber or other similar material.

Thus the invention also provides a method of applying a pattern or decoration to the surface of an article to be decorated comprising producing an image of the pattern or decoration by electrostatic means and transferring the image to the surface to be decorated by means of one or more transfer members effecting transfer by direct surface contact.

According to a further aspect of the invention there is provided image transfer apparatus comprising means for producing an electrostatic image of an original pattern or decoration to be applied to a surface to be decorated and means for transferring the image to the surface in one or more stages by direct surface contact.

The apparatus may be employed in the production of lithographs or transfers for decoration of articles, in which case said surface comprises a coated paper or other substrate on to which the image is transferred and from which the lithograph or transfer is produced by application of one or more surface coating layers over the transferred image.

Alternatively the apparatus may be employed for direct application of the image to the surface to be decorated, in which case said means for transferring said image preferably comprises an intermediate support member on to which said image is transferred by said electrostatic image-producing means, and a further transfer member adapted to pick-up the image from said intermediate support member by surface contact therewith and transfer same to the surface of the article to be decorated.

Preferably said further transfer member comprises a deformable pad of silicone rubber or other flexible material. Advantageously said pad is hollow and includes means for introducing fluid into the hollow interior thereof to control deformation of the pad. The pad may also incorporate heating means.

Transfer of the image from said electrostatic

reproducing means to said intermediate support member may advantageously be assisted by corona discharge.

The hollow pad member may be used with conventional intaglio printing techniques or with other forms of transfer printing apparatus whether for production of transfers or for direct or indirect decoration of articles of ware. Thus the invention also provides a transfer printing member comprising a hollow pad of flexible material having means for introducing fluid under pressure into the interior thereof whereby to control the deformation and if desired the temperature thereof.

The invention also includes a transfer produced by and an article decorated by the method or apparatus aforesaid.

Embodiments of the invention will now be described, by way of example only, and partly with reference to the accompanying diagrammatic drawing which is a cross-section through one form of image transfer apparatus for use in the decoration of ceramic articles such as plates.

Referring to the drawing, the apparatus includes an electrostatic image forming drum 5 the surface 6 of



which is coated with a photo-conductive material such as zinc oxide or selenium. In operation the drum rotates in a clockwise direction as viewed in the drawing such that its surface passes in turn through four zones. In the first zone it is exposed to corona discharge means producing a negative electrical charge at the surface of the oxide layer. At the next zone the original pattern or decoration 8 to be transferred is exposed through a lense 9 to the charged surface of the drum. The level of light intensity falling on different areas of the charged surface of the drum modifies the electrical charge dependent on the light level and thereby produces an electrostatic charge pattern corresponding in intensity to the tonal variations of the original pattern or decoration 8. This electrostatic latent image is then carried around by the drum to the third zone where positively charged toner particles 10 are directed from a hopper 11 towards the charged surface and adhere thereto by electrostatic action to extents dependent on the level of charge at the different areas of the surface. Excess toner particles are collected in a trough 12 for re-cycling.

Thus at this stage there is reproduced on the surface of the drum a toner image of the original pattern or decoration in electrostatically charged toner particles. As the image is to be applied to a ceramic

article which will be subjected to substantial firing temperatures of the order of 600° to 1100°C, the pigments of the toner must be composed of materials capable of withstanding such temperatures. Preferably the toner consists of particles of metal oxide pigments or other vitrifiable materials mixed with resin to both enhance its electrostatic properties and bind the pigments together. Typically the toner will comprise lead oxide, boron, flint or other forms of silica together with ceramic pigments formed from a range of materials such as copper oxide, iron and cobalt compounds and oxides of chromium, manganese, nickel and gold. These materials are mixed with thermoplastic polymers such as acrylics, polyamides, hydrocarbon resins and epoxides, selected with regard to their softening points and hardness and carefully chosen to impart the correct electrical charge to the system. The resins act as a carrier for the pigments and fuse under heat to form a thermoplastic ink during subsequent stages of transfer of the article to be decorated. The preferred resins are alkyd or acrylic based compounds in the form of monomers, oligomers or prepolymers.

Continued rotation of the drum brings the electrostatically formed toner image to the lower position shown in the drawing where it is brought into direct contact with the upper surface of a continuous

belt 13 entrained round pulleys 14 and 15 and driven so as to move in the same direction as and at the same peripheral speed as the adjacent surface of the drum 5. Corona discharge means 16 is mounted beneath the upper surface of the belt 13 in the region where it is contacted by the drum 5 and the toner image is transferred from the surface of the drum to the upper surface of the belt by virtue of the contact pressure between them assisted by the corona discharge.

It is to be noted that the technique does not involve "jumping" of the image from the drum to the belt. Transfer is effected by direct contact under pressure and the corona discharge means serves merely to control the electrical polarity to cause the image to release from the drum and adhere to the surface of the belt. The surface of the drum continues to rotate towards the first zone where the cycle recommences.

The image transferred from the drum to the upper surface of the belt 13 is carried by the belt to the left as shown in the drawing to a pick-up area above which is located a movable transfer member comprising a hollow pad 17 of silicone rubber secured to a support 18. The support is adapted to be moved vertically downwards to bring the pad into contact with the upper surface of the belt 13 to pick-up the image therefrom

and may then be moved horizontally to the position shown at 17A where it is located above a plate 19 to be decorated mounted on a suitable support 20. The pad may then be moved vertically downwards into contact with the surface of the unheated plate to transfer the image thereto.

The hollow interior of the pad is adapted to be supplied with air or hydraulic fluid under controlled pressure and temperature to assist deformation of the pad and to control its temperature. The temperatures and pressures applied during operation of the pad 17 are controlled by control means (not shown) such that following contact of the pad with the image on the belt 13 the image adheres to the surface of the pad and is released from the belt and following contact between the pad and the plate 19, which is unheated, the image adheres to the plate and releases from the pad. The fluid filled nature of the pad allows a more even deformation pressure across the total surface of the pad than can be achieved from a solid pad.

It is to be noted that at all stages following formation of the electrostatic image, transfer is effected by direct contact between the surfaces concerned. This is advantageous in maintaining the integrity of the high definition electrostatically

formed image throughout the process from the time it is released from the drum 5 to its application to the ware 19. At no stage is the image transferred by "jumping" from one surface to another and the loss of definition associated with such techniques is therefore eliminated. The electrostatic reproduction means employed initially produces a high definition image the quality of which is therefore maintained throughout the transfer process. The quality of the image may be further enhanced by utilizing digitally controlled raster image processing methods.

In an alternative embodiment the invention is employed in the production of ceramic lithographs or transfers for subsequent use in the decoration of articles of ware. For this purpose the belt 13 may carry or may be replaced by a transfer substrate such as coated paper on to which the electrostatically produced images are transferred directly. The transfer substrate comprises a base or carrier having a surface coating or release layer which serves subsequently to enable separation of the image from the carrier. Following application of the image to the substrate suitable coating layers are applied over the transfer in order to entrap the image between the coating layers and the substrate. In use of such transfers the coating layer or layers and the image are separated from the substrate

and transferred to the surface of the article to be decorated, following which they are subjected to a firing operation to burn-off the cover layers and fuse the image to the article. The release layer may be designed to permit separation from the carrier by moistening, heating or other means.

In a further modification heated ware emerging from a kiln may be decorated by direct application of an image produced electrostatically, the image being fused to the ware by the residual heat in the ware prior to cooling. In this way the operations of firing the ware, applying the decoration, firing or fusing the decoration and cooling the ware are carried out in sequence, the decoration being fused to the ware utilizing the residual heat remaining in the ware following firing and before cooling. It is therefore unnecessary to re-heat the ware for the purpose of firing on the decoration at a later stage.

The invention may be employed to transfer both monotone (black and white) and multicolour images. For the latter purpose a multicolour electrostatic image-producing or copying means is employed. The machine may be equipped with means for analysing a colour original and selecting combinations of toner in primary colours to reproduce the original colours. The coloured

toner image is then transferred by direct contact to the transfer substrate or article of ware as described above.

Various modifications may be made without departing from the invention. For example when used for the direct decoration of articles the intermediate conveyor may be replaced by a sliding plate or in some cases may be eliminated entirely, the image being transferred direct from the electrostatic drum to the flexible transfer member 17. However such a system, while resulting in simplification of the apparatus, may involve cleaning problems which become particularly acute as speed of operation increases. By use of an intermediate transfer member, means may be provided for cleaning the latter without directly affecting operation of the electrostatic drum or the final transfer member. Adherence of toner may be enhanced by application of a variably controlled electrical signal to the corona discharge unit to vary the level of electrical charge applied to the drum to suit different toner materials. The construction arrangement and manner of operation of the electrostatic image-forming means, the final transfer member and, where provided, the intermediate carrier member may also be modified subject only to incorporation of initial electrostatic image-forming and subsequent transfer by direct surface to surface

contact.

Whilst endeavouring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.



CLAIMS

1. An image transfer method comprising producing an image of an original pattern or decoration by electrostatic means on the surface of an intermediate carrier member and transferring the electrostatically produced image from said carrier member to a support surface using a direct contact transfer technique.
2. A method according to claim 1 wherein said image is subjected to heat during said direct contact transfer stage.
3. A method according to claim 1 or 2 wherein said image is subjected to pressure during said direct contact transfer stage.
4. A method according to claim 1, 2 or 3 wherein transfer of said image from said carrier member to said support surface is assisted by corona discharge.
5. A method according to any preceding claim for the production of a lithograph or transfer wherein said support surface comprises a transfer substrate.
6. A method of producing lithographs or transfers

comprising producing an image of a pattern or decoration by electrostatic means and transferring said image to the surface of a transfer substrate by direct contact therewith.

7. A method according to any of claims 1 to 4 for the direct decoration of articles, wherein said image is transferred from said carrier member to the surface to be decorated by one or more transfer stages involving direct surface contact.

8. A method of applying a pattern or decoration to the surface of an article to be decorated comprising producing an image of the pattern or decoration by electrostatic means and transferring the image to the surface to be decorated by means of one or more transfer members effecting transfer by direct surface contact.

9. A method according to claim 7 or 8 wherein said image is transferred in a single stage by picking up the image from an intermediate support and applying it directly to the surface to be decorated by contact therewith.

10. A method according to any of claims 1 to 4 or 7 to 9 wherein the image is applied to the surface of an article to be decorated after firing of the article and

before cooling, whereby the residual heat in the article causes fusing of the image to the surface of the article.

11. A method of producing and decorating an article of ceramic ware comprising firing the article, producing an image of a pattern or decoration by electrostatic means, and applying the image to the surface of the article by direct surface contact after firing and before cooling of the article, whereby the residual heat in the article is effective to fuse the image to the surface of the article.

12. Methods of electrostatic image transfer by direct surface contact substantially as hereinbefore described.

13. Image transfer apparatus comprising means for producing an electrostatic image of an original pattern or decoration to be applied to a surface to be decorated and means for transferring the image to the surface in one or more stages by direct surface contact.

14. Apparatus according to claim 13 for the production of lithographs or transfers, wherein said surface comprises a transfer substrate.

15. Apparatus according to claim 13 for direct

application of said image to the surface to be decorated, wherein said means for transferring the image comprises an intermediate support member on to which said image is transferred by said electrostatic image-producing means, and a further transfer member adapted to pick-up the image from said intermediate support member by surface contact therewith and transfer same to the surface to the article to be decorated.

16. Apparatus according to claim 15 wherein said further transfer member comprises a deformable pad of flexible material.

17. Apparatus according to claim 16 wherein said pad comprises silicone rubber.

18. Apparatus according to claim 16 or 17 wherein said pad is hollow and includes means for introducing fluid into the hollow interior thereof to control deformation of the pad.

19. Apparatus according to any of claims 16 to 18 wherein said pad incorporates heating means.

20. Apparatus according to any of claims 13 to 19 including corona discharge means operable to assist the direct contact transfer of said image.

21. Image transfer apparatus substantially as hereinbefore described with reference to the accompanying drawing.

22. A transfer printing member comprising a hollow pad of flexible material having means for introducing fluid under pressure into the interior thereof.

23. A printing member according to claim 22 wherein said fluid is air under pressure.

24. A printing member according to claim 22 wherein said fluid is hydraulic fluid.

25. A printing member according to any of claims 22 to 24 including means for controlling the pressure of fluid introduced into the pad during use.

26. A printing member according to any of claims 22 to 25 including means for controlling the temperature of fluid introduced into the pad during use.

27. A transfer printing member in the form of a flexible pad substantially as hereinbefore described with reference to the accompanying drawing.

28. A transfer produced by the method according to any

of claims 1 to 6 or 10.

29. A transfer produced using the apparatus of any of claims 13, 14, 20 or 21.

30. An article decorated by the method according to any of claims 1 to 4 or 7 to 12.

31. An article decorated using the apparatus of any of claims 13 or 15 to 21.